

ELECTRONIC FUNDAMENTALS

EXPERIMENT LESSON 33

ALIGNMENT OF SUPERHETERODYNE RECEIVERS



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Experiment Lesson 33

INTRODUCTION

The superheterodyne receiver is capable of high gain and excellent selectivity. However, the best performance from this receiver is obtained only when the various tuned circuits are adjusted to the correct resonant frequency. The process of adjusting the tuned circuits is called *alignment*. For a broadcast-band AM receiver, the alignment process consists of the following:

1. Tuning the intermediate frequency transformers to resonance at the intermediate frequency, which is 455 kc.

2. Tuning the r-f circuits to resonance at the frequency of the incoming signal.

3. Tuning the oscillator so that it is 455 kc above the frequency of the incoming signal.

4. Alignment of the i-f stages, the procedure for which has been given in a previous Experiment Lesson.

To make it possible for both the oscillator and r-f tuning circuits to be adjusted with a single front panel control, the r-f tuning capacitor and the oscillator tuning capacitor are *ganged*; that is, they are mounted on a common shaft. Because of this arrangement, the two tuned circuits need to be adjusted so that their resonant frequencies are always 455 kc apart. Two or more circuits adjusted so as to maintain a certain relationship are said to be *tracked*. Thus, there are the following two parts to the r-f and oscillator alignment:

1. Adjusting the oscillator so as to bring in broadcast stations at the point called for by the receiver tuning dial. In order for this to happen, the oscillator frequency must be 455 kc above the desired station at the point called for by the dial.

2. Adjusting the r-f tuned circuits so that, as each station is brought in by the oscillator, the r-f circuit has maximum response for that station. This will happen if the r-f circuit is tuned 455 kc below the oscillator frequency.

Absolutely perfect tracking cannot be obtained over the entire broadcast band. Perfect tracking can be obtained only at three points in the band. The exact points at which tracking occurs can be varied by adjustment of the oscillator and r-f tuned circuits. By careful adjustment it is possible to make the three points of perfect tracking, or *crossover points*, occur as shown in Fig. 33-1. Points 1 and 3 are about 10 percent in from the extremes of the broadcast band, or at about 600 kc and 1,400 kc. Point 2 is at the center of the band, or about 1,000 kc. By making the r-f and oscillator circuits track at these three points, the maximum tracking error on the lower half of the broadcast band is about the same as that on the upper half of the band, and the tracking error in between is small enough to be neglected. If the crossover points occur at other frequencies, such as shown in Fig. 33-2, then the tracking error at certain points, such as at X would be high, and cause reduced pickup of signals at or near this frequency.

Adjustment of the oscillator and r-f circuits is accomplished either by small

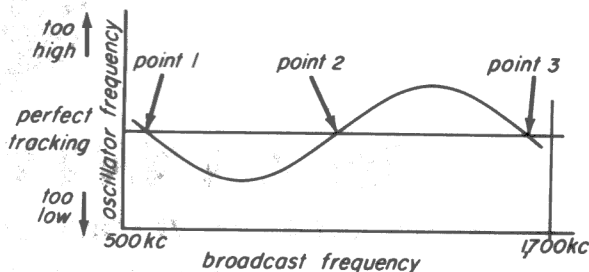


Fig. 33-1

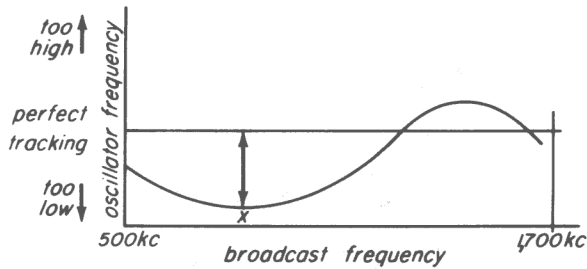


Fig. 33-2

variable capacitors or by adjustable cores. A small variable capacitor connected in parallel with the main tuning capacitor as shown schematically in Fig. 33-3, is called a *trimmer* capacitor. A small variable capacitor connected in series with the main tuning capacitor as shown schematically in Fig. 33-4, is called a *padder* capacitor. The alignment of a superheterodyne receiver can be performed more easily when you know the effect of these various adjustments on the tuning of the circuit. In this Experiment Lesson, you will see that the effect of a parallel trimmer is greatest on the high-frequency end of the broadcast band. It will also be shown that the effect of a series padder is greatest on the low-frequency end of the broadcast band and that the effect of an adjustable inductance is also greatest on the low-frequency end of the broadcast band.

These experiments will also demonstrate other principles that are important to the alignment process.

EQUIPMENT NEEDED

Receiver chassis

Multimeter

Signal generator

270- μF capacitor

Loop antenna

Radio-receiver dial knob

JOB 33-1

To align the i-f stage, if necessary.

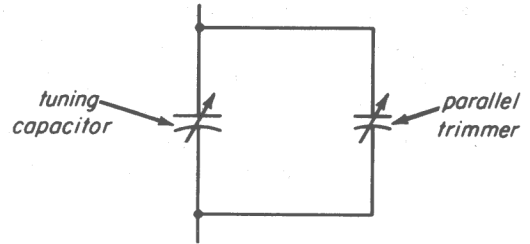


Fig. 33-3

Procedure.

If necessary, realign or check the alignment of the i-f stages as described in the Experiment Lesson on i-f amplifiers. Disable the oscillator during the i-f alignment by connecting a clip lead from pin 5 of the converter tube to the chassis. Make the final i-f adjustments with the input signal applied to pin 8 of the converter tube.

EXPERIMENT 33-1

To determine the effect of varying the tuned circuit inductance on the high end and low end of the broadcast band.

Procedure.

Step 1. Connect the hot lead of the signal generator to the antenna coupling coil. Connect the ground lead of the signal generator to the chassis. Be careful to arrange the leads so that the hot alligator clip does not short to the mounting bracket.

Step 2. Set up the meter to the 15 VAC range and insert the positive test lead in the OUTPUT jack.

Step 3. Remove the converter tube and insert the negative test prod into pin 8 of the converter tube socket from the top of the chassis; connect positive prod to chassis. This is done so that the ex-

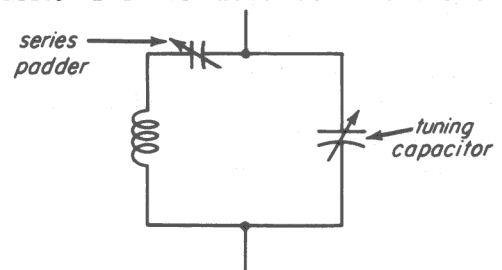


Fig. 33-4

periment can be conveniently performed with the chassis right side up. The meter will read r.f., as explained in a previous experiment lesson. Make sure to count counterclockwise when viewing the tube socket from the top of the chassis (Fig. 33-5).

Step 4. Turn on the signal generator, and set it to band B, about 1,700 kc. Turn the AF OUT/INT MOD switch off, and the RF ATTEN control to maximum.

Step 5. Turn on the receiver and allow the tubes to warm up.

Step 6. Turn the adjustable core on the antenna coil all the way in—to its maximum inductance position. (Leave about 1/8 inch of the threaded screw out.)

Step 7. Adjust the tuning capacitor to its minimum capacity position.

Step 8. Gently tighten the trimmer capacitor on the front section to its maximum capacity position; then back it off about $\frac{3}{4}$ turn.

Step 9. Tune the signal generator back and forth in the vicinity of 1,700 kc, and tune for maximum response. If insufficient meter deflection is obtained, move the turns of the 3-turn coupling coil closer to the antenna-coil winding. If the meter needle swings off scale, reduce the r-f output. Record the resonant frequency of the r-f tuned circuit here:

1700
kc

Step 10. Set the variable tuning capacitor to its maximum-capacity setting, and again tune the signal generator for maximum response. (This should occur somewhere near 450 kc on band A.) Record the resonant frequency here:

500
kc

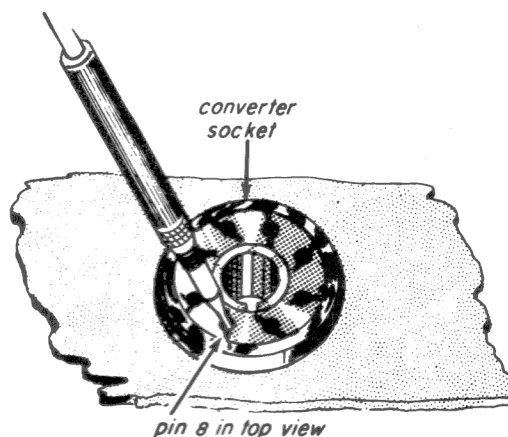


Fig. 33-5

Step 11. Back the adjustable core out of the antenna coil for about $\frac{3}{8}$ inch.

Step 12. Repeat Steps 9 and 10 to find the resonant frequencies at the high and low end of the band for the new inductance. Record the new resonant frequencies here:

High end 5%

1810
kc

Low end 8%

540
kc

Step 13. Turn off the receiver.

What is the percentage change in the high-end resonant frequency due to the change in inductance?

What is the percentage change in the low-end resonant frequency due to the change in inductance?

Which end of the broadcast band—high or low—is affected more by a change in inductance?

Discussion. Your results for this experiment should show that a change in inductance has a greater effect on the low end of the broadcast band than on the high end. Although you have performed the experiment in the r-f tuned circuit, the principle applies equally well to the oscillator tuned circuit. Thus, if either the antenna

coil or oscillator coil is adjustable, adjustments would be used to obtain the desired tracking nearest the low end of the band.

In this experiment, with the antenna coil core all the way in, the resonant frequency at minimum capacity is about 1,700 kc, and at maximum capacity it is about 450 kc. Reducing the antenna-coil inductance by backing out the core about 3/8-inch raises the resonant frequency of the antenna circuit to about 1,800 kc at minimum capacity and to about 500 kc at maximum setting of the tuning capacitor. Thus, there is a change of about 100 kc at the high end and 50 kc at the low end. But at the low end this represents about an 11 percent change, while at the high end this represents about a 5 percent change.

EXPERIMENT 33-2

To determine the effect of varying a parallel trimmer capacitor on the high end and the low end of the broadcast band.

Procedure.

Step 1. Disconnect the ferrite-rod antenna coil from TS-L on top of the chassis, and connect the loop antenna to this terminal strip.

Step 2. Gently adjust the front section of the trimmer capacitor to its maximum capacity position. Turn the tuning capacitor to its fully open (minimum capacity) position.

Step 3. Turn on the receiver and allow the tubes to warm up.

Step 4. Cut an 18-inch length of hookup wire and strip about 1/2-inch of insulation from each end. Insert the wire into the slots in your loop antenna form, as shown in Fig. 33-6, and connect your signal-generator cable across the ends of the wire as shown. Set the RF ATTEN control to about midposition.

Step 5. With the meter set up to the 15 VAC scale and connected to pin 8 of the converter tube as in the previous experiment, tune the signal generator for maximum response, which should occur at about

1,400 kc (band B). Record the resonant frequency here:

1400 kc

Step 6. Turn the tuning capacitor to its fully closed position, and find the new resonant frequency. Record it here:

575 kc

Step 7. Carefully turn the trimmer adjustment screw out for about two full turns.

Step 8. Find the new resonant frequencies with the tuning capacitor set to its fully opened and fully closed positions. Record the resonant frequencies here:

High end

+7%

1590 kc

Low end

27%

585 kc

1420
200
1400
2
10
575
1510.00

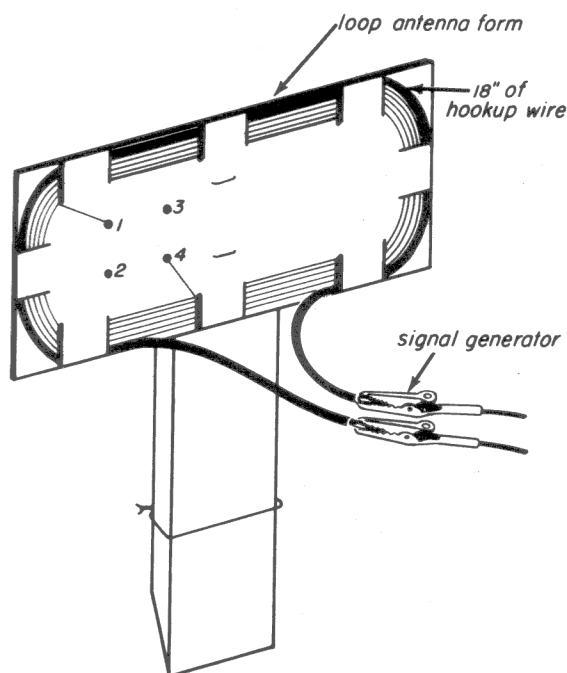


Fig. 33-6

Step 9. Turn off the receiver.

What is the percentage change in the high-end resonant frequency due to the change in trimmer capacity? *14%*

What is the percentage change in the low-end resonant frequency due to the change in trimmer capacity? *2%*

Which is affected more by a change in trimmer capacity, the high end of the broadcast band or the low end of the broadcast band? *High*

Discussion. Your results for this experiment should show that the effect of a trimmer capacitor is much greater on the high end of the band than on the low end of the band. Thus, either the r-f circuit trimmer or the oscillator circuit trimmer is adjusted to obtain proper tracking on the high end of the band.

In this experiment, with the trimmer set for maximum capacity, the resonant frequency of the r-f circuit is about 1,400 kc when the tuning capacitor is fully open, and about 535 kc with the tuning capacitor fully closed. Decreasing the trimmer capacitance by opening it up two full turns raises the resonant frequency to about 1,700 kc at the fully open position of the tuning capacitor, and makes it about 550 kc at the fully closed position of the tuning capacitor. Thus the change in trimmer capacitance produces a change of about 3 percent at the low end of the broadcast band compared to a change of 20 percent at the high end of the broadcast band.

EXPERIMENT 33-3

To determine the effect of a padder capacitor on the high end and the low end of the broadcast band.

Procedure.

Step 1. Gently tighten the front-section trimmer to its maximum closed position.

Step 2. The resonant frequency at the open and closed positions of the tuning

capacitor should now be the same as determined in Steps 5 and 6 of Experiment 33-2. Copy these frequencies here:

High end

1400 kc

Low end

535 kc

Step 3. Disconnect one lead of the loop antenna from TS-L and insert a 270- μ f capacitor in series with the loop antenna lead wire.

Step 4. Turn on the receiver and allow the tubes to warm up.

Step 5. Check to see that the signal generator is on, modulation off, and connected to the loop antenna as in Fig. 33-6.

Step 6. Check to see that one probe of the meter is inserted in Pin 8 of the converter tube as in Fig. 33-5, and the other lead connected to chassis.

Step 7. With the tuning capacitor fully open, tune the signal generator for maximum response. Record the resonant frequency here:

1450 kc

Step 8. Adjust the tuning capacitor to its fully closed position, and tune the signal generator for maximum response. Record the resonant frequency here:

860 kc

Step 9. Turn off the receiver. Remove the 270- μ f capacitor and reconnect the loop antenna lead.

What is the percentage change in the high-end resonant frequency due to the insertion

50
1400
300
600
1450
1400
50

of the series padder capacitor?

3%

What is the percentage change in the low-end resonant frequency due to the insertion of the series padder capacitor?

50%

Which is affected more by a series padder, the high end of the broadcast band or the low end of the broadcast band?

LOW END

Discussion. The results of this experiment should show that the series padder capacitor affects the low end of the broadcast band much more than it affects the high end of the broadcast band. Series padder capacitors are usually used only in the oscillator tuning circuits. In this case, the padder, if variable, is used to obtain the desired oscillator tracking at the low end of the broadcast band.

Typical numerical results for this experiment are as follows: Without the series padder, the resonant frequency of the r-f circuit varies from about 535 kc to 1,400 kc as in the previous experiment. Inserting the padder in series with the loop raises the resonant frequency from about 850 kc with the tuning capacitor fully closed to about 1,500 kc with the tuning capacitor fully opened. Thus, this series padder produces a change of almost 60 percent at the low end compared to a change of only about 6 percent at the high end.

To summarize the relationships determined in the last few experiments:

1. A parallel trimmer capacitor has greatest effect on the high end of the band.
2. A series padder capacitor has greatest effect on the low end of the band.
3. A variable inductance in a tuned circuit has greatest effect on the low end of the band, similar to a series padder.

EXPERIMENT 33-4

To learn the theory of operation and the use of a *tuning wand*.

Information. When you are aligning tuned circuits in radio, television, or other elec-

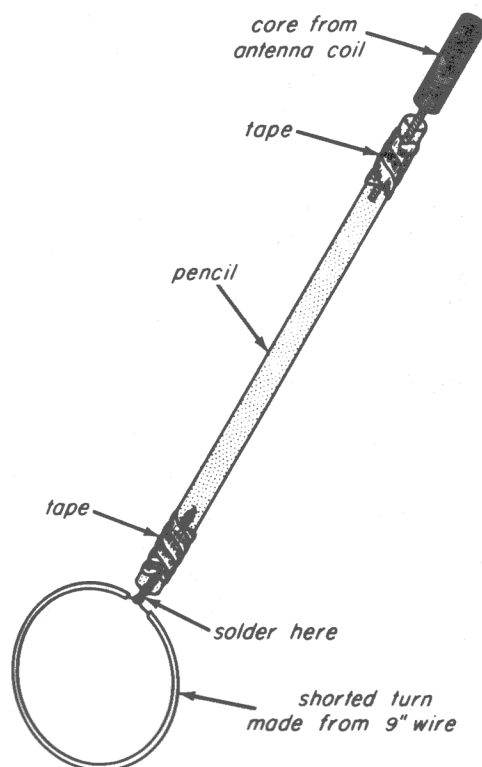


Fig. 33-7

tronic circuits, it may sometimes be very helpful to know whether or not a particular circuit is tuned to resonance. One way in which this can be done is to increase and decrease the frequency of the applied signal and note whether a greater response is obtained. Another way is to vary the tuning of either the inductance or capacitance in the circuit and note whether the response increases. However, in many cases, it is not convenient to use either of these methods. For example, if the signal used is that of a broadcast station, its frequency cannot be changed. Disturbing the tuning of the circuit may not be desirable because it may take a lot of time to tune it up again. By means of a *tuning wand*, the tuning of the circuit can be examined without changing the frequency of the applied signal or disturbing the circuit.

The construction of a tuning wand is shown in Fig. 33-7. It consists of an insulating rod with a core or slug of magnetic material (usually powdered iron) at one end and a single shorted turn of wire at the other end. Other forms of tuning wands use slugs of brass or other *nonmagnetic* materials in place of the shorted turn. When the magnetic material is brought near a coil

under test, its inductance is increased. When the shorted turn or nonmagnetic material is brought near the coil under test, its inductance is decreased.

Bringing magnetic material near the coil increases its inductance because the high permeability of the core allows more flux to be set up. The greater the flux set up by a coil, the greater its inductance.

Bringing the nonmagnetic material or shorted turn near the coil decreases its inductance, because the magnetic field of the coil induces a current in the shorted turn or brass slug. This induced current produces a magnetic field that opposes the magnetic field of the coil under test. The opposing field reduces the total flux of the coil, thus reducing its inductance.

When either side of the tuning wand is brought near the coil of a circuit that is tuned exactly to resonance, as in Fig. 33-8a, the circuit will be thrown off resonance, causing a decrease in response. Thus, if either end of the tuning wand causes a decrease in response, it is an indication that the circuit is tuned exactly to resonance.

If the circuit has too much inductance, as shown in Fig. 33-8b, approaching it with the magnetic end of the wand increases the inductance and causes a decrease in the response; approaching the coil with the shorted turn or brass end decreases the inductance and increases the response.

If the circuit has too little inductance, as shown in Fig. 33-8c, approaching with the magnetic end of the wand will increase the inductance and increase the response; approaching with the shorted turn or brass end will decrease the inductance and decrease the response.

The effect of increasing the capacity in a circuit is the same as that of increasing the inductance. Both lower the resonant frequency of the circuit. Also, decreasing the inductance in a tuned circuit has the same effect as decreasing the capacitance. Both raise the resonant frequency of the circuit. Thus, depending upon which

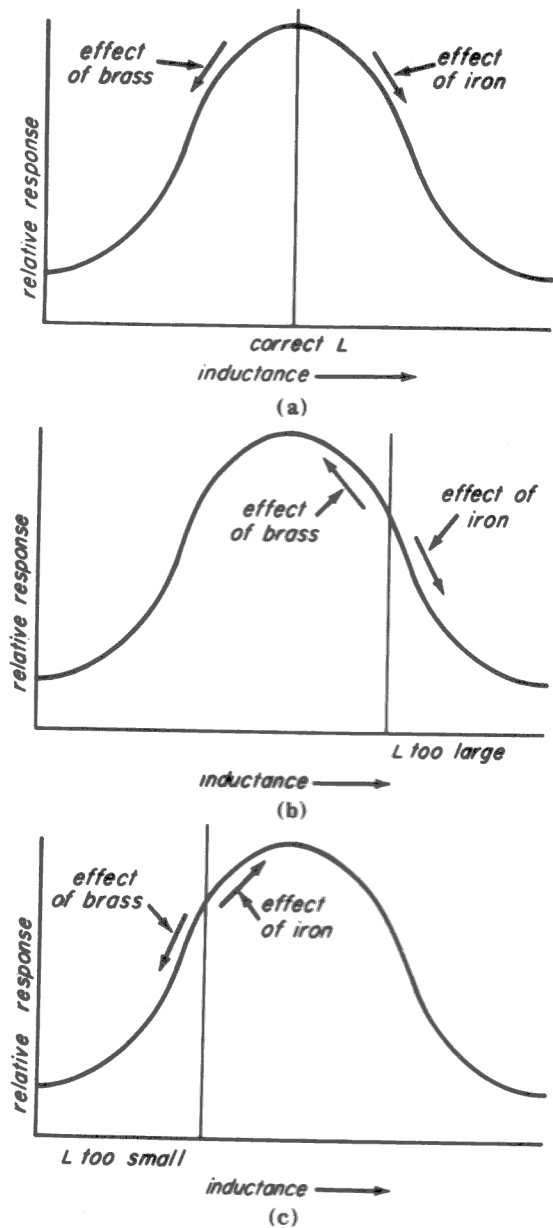


Fig. 33-8

is variable, the tuning wand indication tells us how to adjust either the adjustable capacitor or adjustable inductance in the circuit. The indication gives the following information:

1. If approaching with either end of the wand causes a decrease in response, the circuit is correctly tuned.
2. If approaching with the magnetic end of the wand produces an increase in response, either the inductance or the capacitance needs to be increased.
3. If approaching with the nonmagnetic end of the wand produces an increase in re-

sponse, either the inductance or capacitance needs to be decreased.

Procedure.

Step 1. Cut a 9-inch length of hookup wire and strip $\frac{1}{2}$ -inch of insulation from each end. Form the wire into a circle, as shown in Fig. 33-7, twist the ends together, and solder them to make a shorted turn.

Step 2. Carefully unscrew the adjustable core from the antenna coil.

Step 3. Tape the core and the shorted turn to opposite ends of a pencil, as shown in Fig. 33-7, to make a tuning wand. Use a new or fairly long pencil, so that the core and shorted turn are well separated.

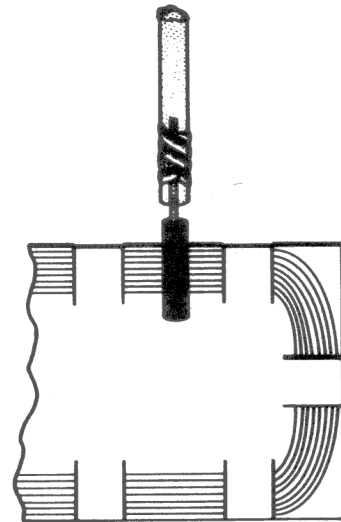
Step 4. Check to see that the converter tube is removed, and the meter prod inserted in pin 8 of the converter tube socket (shown in Fig. 33-5), and the other meter lead is connected to the chassis. The meter should be set up to the 15 VAC range.

Step 5. Turn on the receiver and signal generator and allow them to warm up.

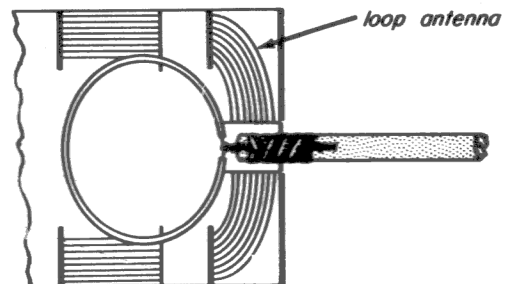
Step 6. Set up the signal generator to band B, about 1,000 kc, and check that the modulation switch is turned off.

Step 7. Set the tuning capacitor to its midposition and then tune it for maximum response on the meter. Then make a final adjustment with the signal generator tuning to make sure the response is at maximum.

Step 8. Bring each end of the tuning wand near the loop and note the response below. When the powdered iron core is brought near the loop, it should be held perpendicular to the loop wires, as shown in Fig. 33-9a. When the shorted turn is brought near the loop it should be just inside the loop wires, as shown in Fig. 33-9b. Hold the tuning wand by the end that is not in use so as to keep your hand as far away from the loop as possible.



(a)



(b)

Fig. 33-9

At resonance

The magnetic end

decreases
the response.

The nonmagnetic end

decreases
the response.

Step 9. Now turn the capacitor in the direction of *increasing* capacity to reduce the meter deflection to about half.

Step 10. Predict what will happen when you bring the magnetic end of the wand near the coil.

decrease

Predict what will happen when you bring the nonmagnetic end near the coil.

increase

Step 11. Approach the loop antenna with each end of the tuning wand as in Fig. 33-

9, and verify your prediction. *TRUE*

Step 12. Retune the capacitor to resonance, and then turn it in the direction of *decreasing* capacity to reduce the meter deflection to about half.

Step 13. Approach the loop antenna with each end of the tuning wand. Record your results here:

Magnetic end

INCREASE

Nonmagnetic end

DECREASE

Step 14. Turn off the receiver. Take apart your tuning wand, and replace the core in the antenna coil.

EXPERIMENT 33-5

To study the capacitance range requirements in the oscillator circuit.

Information. The local oscillator in the superheterodyne receiver operates above the incoming signal. It might be thought that the oscillator could operate with a capacitor identical to the r-f capacitor by using a coil having less inductance. This experiment will show that this is not the case. Using a smaller inductance with the same capacitor will make the oscillator operate above the incoming signal, but the oscillator will not have the required tuning range.

Let us consider the tuning range requirements of the r-f circuit and the oscillator circuit. For easy figuring, let's say that the broadcast band extends from 500 kc to 1,500 kc. Thus, the r-f frequency ratio is 3:1. For an i-f of 455 kc, the corresponding oscillator frequency will range from 955 kc to 1,955 kc, which is almost 1,000 kc to 2,000 kc. Thus the required oscillator ratio is about 2:1 as compared to an r-f range of 3:1. Making the oscillator inductance smaller will make the oscillator frequency higher, but will not

change the ratio of the highest to the lowest frequencies produced. The only way to obtain the required ratio of oscillator frequencies is to reduce the *capacity range* of the oscillator capacitor. This can be done either by using smaller plates for the oscillator capacitor or by inserting a padder capacitor in series with the oscillator capacitor. In this experiment, these principles will be demonstrated, using the r-f tuned circuit. However, the principles apply to all resonant circuits.

Procedure.

Step 1. Disconnect the loop antenna and connect in its place the adjustable antenna coil. Remember to resolder the ground on the antenna-coupling coil.

Step 2. Connect the signal generator leads across the coupling coil.

Step 3. Check to see that the meter is connected to the chassis and to pin 8 at the top of the converter socket.

Step 4. Turn on the receiver and signal generator and allow the tubes to warm up.

Step 5. Set the tuning capacitor to its maximum-capacity position.

Step 6. Set up the signal generator to deliver 600 kc, with the r-f output control set to its midposition. The modulation switch should be turned off.

Step 7. Adjust the core of the antenna coil for maximum response. (The threaded screw will be about $\frac{1}{2}$ -inch out.)

Step 8. Adjust the tuning capacitor to its minimum-capacity position and vary the signal-generator tuning until the resonant frequency is found. (Try band C, around 1,700 kc.) Record it here:

1800
kc

600/1800 = 3:1

Step 9. Divide the lower frequency into the higher frequency to find the frequency range.

Note your result here:

3:1

Step 10. Reset the tuning capacitor to its maximum capacity position.

Step 11. Set up the signal generator to 1,000 kc, and adjust the antenna coil core to maximum response.

Step 12. Turn the tuning capacitor to its minimum capacity position, and find the new resonant frequency. Record your result here:

3100
kc

Step 13. Turn off the receiver.

Step 14. Divide the lower frequency into the higher frequency to find the tuning range. Note your result here: 3:1
How does the tuning range compare with that of Step 9? Does adjusting the oscillator to a higher frequency change the range of frequencies covered by the oscillator for the same change in capacity?

EXPERIMENT 33-6

To align the r-f tuned circuit to resonance at the 1,400-kc and 600-kc points on the receiver tuning dial; and to check the tracking of the r-f tuned circuit with the receiver tuning dial at other points.

Procedure.

Step 1. Turn the tuning capacitor to its fully closed position, and mount the tuning knob as shown in Fig. 33-10. Then make a mark on the chassis as shown in the figure to serve as a dial pointer.

Step 2. Check to see that the signal generator is on and that the signal-generator leads are connected across the pickup coil. The modulation switch should be off and the r-f output control near maximum.

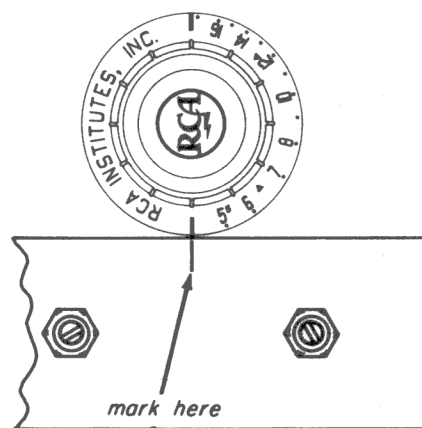


Fig. 33-10

Step 3. Check to see that the meter is set up to the 15 VAC scale, and that the leads are connected to pin 8 in the top of the converter socket and the chassis.

Step 4. Turn on the receiver and allow the tubes to warm up. Preset the core of the antenna coil so that it is just coming out of the coil form.

Step 5. Turn the receiver tuning dial to the 1,400 kc mark and adjust the signal generator to the same frequency.

Step 6. Tune the front section trimmer for maximum response on the meter. If the maximum response is not obtained within the range of trimmer adjustment, turn the core one turn in either direction and try again.

Step 7. Turn the receiver tuning dial to 600 kc and adjust the signal generator to the same frequency.

Step 8. Tune the core of the antenna coil for maximum response on the meter.

Step 9. Repeat the adjustments in Steps 5, 6, 7 and 8, and then repeat 5 and 6 again. (Always finish with the high-frequency adjustment.)

Step 10. Set the signal generator to a number of other frequencies such as 800 kc, 1,000 kc, 1,200 kc, etc., and tune the receiver dial for maximum response at each of these frequencies. How closely does the point of resonance correspond with the receiver dial markings? *Very Close*

Step 11. Turn off the receiver.

EXPERIMENT 33-7

To align the oscillator so that stations are received at the points called for by the receiver tuning dial.

Procedure.

Step 1. Remove the meter test prod from the converter socket and replace the 6SA7 converter tube.

Step 2. Connect the meter to the audio test point on top of the chassis. Connect the other meter lead to the chassis.

Step 3. Turn on the receiver and allow the tubes to warm up.

Step 4. Adjust the RF ATTEN control of the signal generator to about its midposition, and turn the AF OUT/INT MOD switch on.

Step 5. Turn the receiver tuning dial to a quiet spot near 1,400 kc and tune the signal generator to the same frequency.

Step 6. Tune the oscillator trimmer capacitor (on the rear section of the tuning capacitor) for maximum response on the meter. Use the volume control to obtain a convenient amount of meter deflection.

Step 7. Set the receiver tuning dial to 600 kc and adjust the signal generator to the same frequency.

Step 8. Tune the oscillator padder capacitor for maximum response on the meter.

Step 9. Repeat the adjustments of Step 5, 6, 7 and 8 again, and then repeat Steps 5 and 6 once more. (Always finish with the high-frequency adjustment.)

Step 10. Set the signal generator to a number of other frequencies, such as 800 kc, 1,000 kc, 1,200 kc, etc., and tune the receiver dial for maximum response at each one of these frequencies. How closely does the receiver-dial marking correspond with the resonant point?

Good

Step 11. Turn off the receiver.

EXPERIMENT 33-8

To study how the tuning of the oscillator padder affects the point on the dial where low frequency stations are received.

Procedure.

Step 1. Check to see that the signal generator is on, and connected to the pickup coil. The modulation switch should be on, and the r-f output control set to its midposition.

Step 2. Check to see that the meter is set to the 15 VAC scale and is connected to the audio test point on top of the chassis.

Step 3. Turn on the receiver and allow the tubes to warm up.

Step 4. Adjust the receiver dial to the 600 mark and set the signal generator to the same frequency. Do not change the signal generator setting for the rest of the experiment.

Step 5. Tune the oscillator padder for maximum response on the meter.

Step 6. Turn the padder capacitor an additional $\frac{1}{4}$ turn tighter. (Remember that when working from the top of the chassis, the padder adjustment screw is turned *counterclockwise* to tighten.) Does this make for more or less capacity in the padder?

MORE

Step 7. Rotate the receiver tuning dial for maximum response. At what point on the tuning dial does the 600-kc signal come in with too much capacity in the padder?

c 40

Step 8. Restore the padder capacity to its original setting by performing Steps 4 and 5.

Step 9. Turn the screw an additional $\frac{1}{4}$ turn to loosen it. What does this do to the padder capacity?

REDUCE CAPACITY

(Remember that from the top of the chassis clockwise rotation is needed to loosen the padder.)

Step 10. Adjust the receiver tuning dial for maximum response. At what point does the 600-kc signal come in now?

570

Step 11. Restore the padder capacitor to its original setting by performing Steps 4 and 5.

Step 12. Turn off the receiver. Summarize the results of the experiment below:

MORE CAP RAISES DIAL POINT
LESS CAP LOWERS DIAL POINT

If a signal is received above the correct point on the dial, the padder capacitance is too MUCH.

If the signal is received below the correct point on the dial, the padder capacitance is too LITTLE.

Discussion. As the tuning dial is turned from the higher numbers to the lower numbers, the tuning capacitor is closing. If a station at 600 kc is received at 700 on the dial, it means that the required amount of oscillator capacity has been reached too soon. *Thus, if the stations come in too high on the dial, the padder capacitance is too high.* If some padder capacitance is removed, the tuning capacitor can then be rotated more toward its fully closed position, allowing the station at 600 kc to come in closer to 600 on the dial.

If the station at 600 kc is received at 550 on the dial, it means that the required amount of oscillator capacity has not been reached at 600. The capacitor must close more to bring in the 600-kc signal that occurs below 600 on the dial. *Thus, if stations come in too low on the dial, the padder capacitance is too low.* If some padder capacitance is added, the variable capacitor will not have to close as much to get the required total capacitance, and the 600 kc signal will come in closer to 600 on the dial.

EXPERIMENT 33-9

To study the practical alignment procedure including the technique known as *rocking* of

the tuning capacitor for the low frequency adjustment.

Information. In the previous experiments the r-f and oscillator circuits were separately tuned. The r-f circuit was tuned to track with the receiver tuning dial by measuring the r-f output at the plate of the r-f amplifier. Then the r-f oscillator was aligned to track with the dial by using the audio output indication. Although separate alignment in this way illustrates the principles involved, it is not a practical alignment procedure. Many r-f signal generators may not have sufficient output to deflect the meter using only one stage of amplification. Also, if the receiver does not have an r-f amplifier stage, this method cannot be conveniently used. Therefore, alignment of the r-f and oscillator sections are usually performed using the audio output voltage as the resonance indication. Thus, the tuning of the r-f circuit can only be observed through its effect on the audio output produced, which depends upon both the r-f and oscillator tuning. The alignment procedure given below is the practical procedure. Read this procedure for the information in it. At this time do not do what is called for in the procedures.

1. Adjust the receiver tuning dial to a quiet spot on the dial near 1,400 kc, and adjust the signal generator to the same frequency.
2. Adjust the oscillator trimmer capacitor for maximum audio output, using the output meter indication.
3. Without changing the setting of the signal generator or the receiver tuning dial, adjust the r-f trimmer capacitor for maximum audio output.
4. Set the receiver tuning dial to 600 kc, and adjust the signal generator to the same frequency.
5. Tune the oscillator padder capacitor for maximum audio output.
6. Without changing the receiver tuning dial or the setting of the signal generator, adjust the antenna-coil core for maximum response.

7. Readjust the oscillator and r-f trimmers at the high end, as in Step 1, 2 and 3. Then recheck the low-frequency adjustments as in Steps 4, 5 and 6. Continue back and forth until no further improvement is made. Two or three times is usually sufficient. Always finish with the high-frequency adjustment.

In all receivers, we can make sure that the r-f circuit is tracking the oscillator circuit by means of the r-f trimmer capacitor on the r-f section of the tuning capacitor.

In the previous experiment, we were also able to ensure that the r-f tuned circuit was tracking the oscillator circuit at the low end of the band by tuning the antenna coil at this end of the band. However, what if the antenna coil is not adjustable? This is the case in many receivers where a loop antenna is used. How can we tell whether the r-f circuit is tracking the oscillator at the low end of the band? If the r-f circuit is not tracking, how can this be corrected if the antenna coil is not adjustable? Both questions are answered by the alignment technique known as *rocking*.

A previous experiment has shown that it is the oscillator setting that determines at what point on the dial a signal at a certain frequency is received. To review this point, if the padder capacitance is exactly right, a signal at 600 kc will be received at exactly 600 on the dial, as in Fig. 33-11a.

If the padder capacitance is too high, a signal at 600 kc will be received at a higher point on the dial, as shown in Fig. 33-11b, while if the padder capacitance is too low, the 600-kc signal will come in below 600 on the dial, as shown in Fig. 33-11c. Thus, by adjustment of the padder, it is possible to make a 600-kc signal come in either exactly at or above and below 600 on the dial. As far as the oscillator or intermediate frequency circuits are concerned, there is no difference in response for these three positions.

The important difference between these three positions is that the amount of capacitance in the r-f tuned circuit will be different. Thus, by adjusting the padder to make the 600-kc signal come in at different points, we

provide a different amount of r-f capacity for each of these different points. Let us say that by adjustment of the padder we can

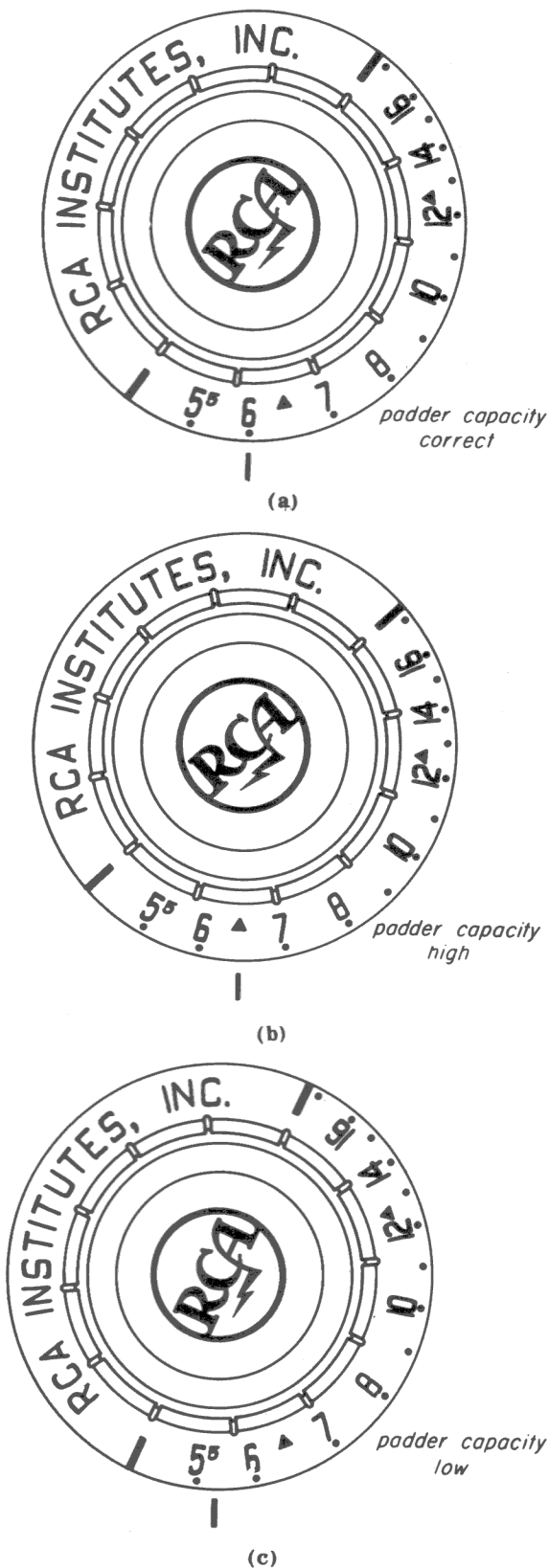


Fig. 33-11

make the 600-kc signal come in when the receiver dial is set to any one of the points numbered 1 to 5 in Fig. 33-12. Only at point 3 is the corresponding amount of r-f capacity just right to make the r-f circuit resonant to 600 kc, as shown in the figure. Thus, the oscillator should be adjusted to make 600 kc come in at point 3. How can this point be found? It is located by the *rocking* procedure. Turn the receiver dial to point 1, with the signal generator set to 600 kc. Then tune the paddler for maximum response, and note the highest voltage indicated by the meter as resonance is passed through. Then set the receiver dial to point 2, and again adjust the paddler for maximum response, noting the highest voltage indicated by the meter as resonance is passed through. If it is higher than the previous maximum, it shows that the correct r-f capacitance is being approached. When the dial is set to position 4, the maximum voltage indicated by the meter will be less than that obtained at position 2, showing that the best point for 600 kc has been passed, and is somewhere between points 2 and 4. By following the same procedure between points 2 and 4, point 3 will be accurately located.

It is quite possible that the point of best r-f response for 600 kc will not correspond to 600 on the dial. If there is only a high-frequency trimmer adjustment, nothing can be done about this, unless the capacitor plates are slotted for bending. You will then have to decide whether it is better to have 600 kc come in a little off the 600 mark on the dial but with best response, or whether some response should be sacrificed to make the stations coincide with the dial.

Procedure.

Step 1. Check to see that the signal generator is on and connected to the pickup coil, with the modulation switch turned on and the r-f output control set to its midposition.

Step 2. Check to see that the meter is set up on the 15 VAC scale and is connected to the audio test point and chassis.

Step 3. Turn on the receiver and allow the tubes to warm up.

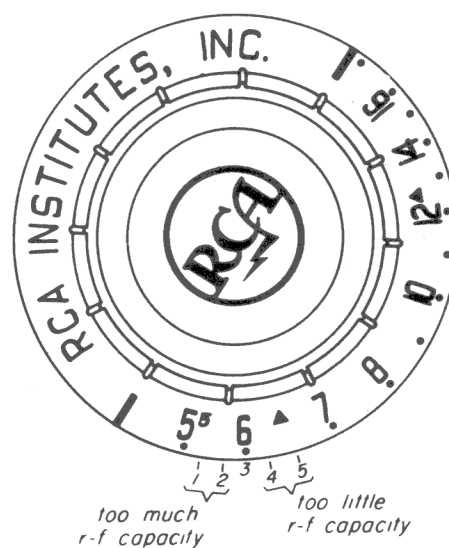


Fig. 33-12

Step 4. Check the adjustment of the high-frequency trimmers by turning the receiver dial to 1,400 kc and tuning the r-f and oscillator trimmers for maximum response.

Step 5. Turn the receiver tuning dial to a point about $\frac{1}{4}$ -inch below the 600 mark on the dial.

Step 6. Adjust the signal generator to 600 kc.

Step 7. Tune the paddler for maximum response and note the maximum deflection of the meter.

Step 8. Move the tuning dial about $\frac{1}{8}$ -inch toward the 600 mark and repeat Step 7. Is the deflection of the meter greater? What does that indicate? _____.

Step 9. Move the tuning dial receiver to the 600 mark, and repeat Step 7. Is the meter deflection greater?

Step 10. Set the tuning dial about $\frac{1}{8}$ -inch above the 600 mark, and repeat Step 7. What about the meter deflection now? What does this indicate? _____.

Step 11. Set the tuning dial at the point where maximum deflection was obtained in the previous steps, and adjust the oscillator paddler for maximum deflection of the meter.

The alignment of the receiver is now complete.